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10/510517

DT05 Rec'd PCT/PTO 07 OCT 2004

DESCRIPTION

Press Belt and Shoe Press Employing the Same

Technical Field

The present invention relates to a press belt employed for pressurizing a zonal material in various industries such as the paper industry, the magnetic recording medium manufacturing industry, the textile industry and the like and a shoe press employing the same.

Background

A press belt is employed for pressurizing a zonal material in various industries. For example, the so-called shoe press is widely used in a dehydrating press in the paper industry. Briefly stated, the shoe press is a device pressing a first surface of a zonal material (wet web) to be pressurized with a press roll or the like while pressurizing a second surface with a pressure shoe having a prescribed width in the running direction through a press belt thereby pressurizing (dehydrating) the zonal material (wet web). While a roll press performing pressing with two rolls applies linear pressure to an object to be pressurized, the shoe press provided with the pressure shoe having the prescribed width in the running direction can apply area pressure to the object to be pressurized. When performing dehydration pressing with the shoe press, therefore, a nip width can be increased for advantageously improving dehydration efficiency. The press belt is endlessly formed by an elastic material such as thermosetting polyurethane. Also in relation to a calendering step of smoothing the surface of a zonal material and setting a gloss thereon in the paper industry or the magnetic recording medium manufacturing industry, calendering employing a press belt such as a belting press or a shoe press similar to the above in place of or along with a roll press has recently been studied in order to improve the quality of a product such as paper or a magnetic recording medium.

In the paper industry, further, particularly when machining paper at a high speed, employment of a similar press belt is studied for a transfer belt preventing web break before or after nip press, and stably transporting wet web.

Fig. 9 is a schematic sectional view of an exemplary conventional shoe press 100 employed for dehydration pressing in a papermaking step. Referring to Fig. 9, wet web 103 held between a top felt member 101 and a bottom felt member 102 is transported into the clearance between a press roll 104 and a belt 105, and dehydrated by pressure formed between the press roll 104 and the belt 105. Both ends of the belt 105 are fixed to discs 109 rotatably supported on both ends of an unrotating support 108 through bearings. The belt 105 rotates in a driven manner following rotation of the press roll 104 while sliding on a pressure shoe 106. The pressure shoe 106 set on the lower surface of the belt 105 applies pressure to a pressurizing region A-A', and this pressure is regulated in response to the pressure of oil injected into hydraulic cylinders 107 set on the lower portion of the pressure shoe 106 through the support 108.

However, the aforementioned shoe press 100 has such a problem that the pressure is not uniformly applied to the overall wet web 103. In other words, the own weight of the large-sized support 108 of metal as well as depression of the press roll 104 deflect a portion close to a central pressurizing portion C as in a support 108a shown in Fig. 10, and the pressure on the central pressurizing portion C is reduced as compared with the pressure on end pressurizing portions A and A'. As a result, the belt 105 is extremely worn from the central pressurizing portion C toward the end pressurizing portions A and A', to induce breakage of the belt 105 on the end pressurizing portions A and A' and shorten the life of the belt 105. While the belt 105 is replaced with a new one when the same is used up, it is not easy to exchange the large-sized belt 105 having a width of 2 to 15 m and a peripheral length of 1 to 30 m but costs labor and time. While a drain is generally formed on the outer peripheral surface of the press belt 105 for dehydration pressing, the dehydration performance for the wet web 103 is rendered insufficient in the vicinity of the end pressurizing portions A and A' when the end

pressurizing portions A and A' of the belt 105 are worn. There is an apprehension that nonuniformity of pressure or nonuniformity of the dehydration performance between the central pressurizing portion C and the end pressurizing portions A and A' may lead to web break in the papermaking step and deterioration of the quality resulting from nonuniform paper strength.

In consideration of the aforementioned circumstances, an object of the present invention is to provide a press belt capable of uniformly applying pressure to a zonal material to be pressurized and a shoe press employing the same. Another object of the present invention is to provide a press belt capable of improving durability of the press belt by preventing the press belt from nonuniform wearing for reducing the cost for a pressing step by reducing the frequency for exchanging the press belt and a shoe press employing the same.

Disclosure of the Invention

In order to attain the aforementioned objects, the press belt according to the present invention, employed for pressurizing a zonal material, is endlessly formed by an elastic material with the thickness progressively reduced from a central pressurizing portion toward end pressurizing portions.

In the press belt according to the present invention, the thickness is preferably progressively reduced from the aforementioned central pressurizing portion toward the aforementioned end pressurizing portions by at least one type of technique selected from a group of a crown curve technique, a linear technique, a stepped technique and a trapezoidal technique.

The press belt according to the present invention preferably includes a cylindrical endless reinforcing base, a first elastic layer located on the outer peripheral surface of the reinforcing base and a second elastic layer located on the inner peripheral surface of the reinforcing base, and the thickness of the first elastic layer is preferably progressively reduced from the central pressurizing portion toward the end pressurizing portions.

Alternatively, the press belt according to the present invention preferably includes a cylindrical endless reinforcing base, a first elastic layer located on the outer peripheral surface of the reinforcing base and a second elastic layer located on the inner peripheral surface of the reinforcing base, and the thickness of the second elastic layer is preferably progressively reduced from the central pressurizing portion toward the end pressurizing portions.

In the press belt according to the present invention, the difference between the thickness of the aforementioned central pressurizing portion and the thickness of the aforementioned end pressurizing portions is preferably 2 to 30 % of the thickness of the aforementioned central pressurizing portion.

The press belt according to the present invention is preferably a papermaking press belt.

Alternatively, the press belt according to the present invention is preferably a shoe press belt.

The present invention also provides a shoe press comprising at least the aforementioned press belt, a pressure shoe applying pressure to the aforementioned press belt and pressure regulation means regulating the pressure of the pressure shoe.

Brief Description of the Drawings

Fig. 1 is a schematic sectional view of a press belt according to a first embodiment.

Fig. 2 is a schematic sectional view of a press belt according to a second embodiment.

Fig. 3 is a schematic sectional view of a press belt according to a third embodiment.

Fig. 4 is a schematic sectional view of a press belt according to a fourth embodiment.

Fig. 5 is a schematic sectional view of a press belt according to a fifth

embodiment.

Fig. 6 is a schematic sectional view of a press belt according to a sixth embodiment.

Fig. 7 is a schematic sectional view of a press belt according to a seventh embodiment.

Fig. 8 is a schematic sectional view of an exemplary shoe press according to the present invention.

Fig. 9 is a schematic sectional view of an exemplary conventional shoe press.

Fig. 10 is a schematic sectional view showing another exemplary conventional shoe press having a support deflected in the vicinity of a central pressurizing portion.

Best Modes for Carrying Out the Invention

Embodiments of the press belt according to the present invention are now described.

(First Embodiment)

Fig. 1 is a schematic sectional view of a press belt 11, an example of the inventive press belt, according to a first embodiment. In the press belt 11 according to the first embodiment, a reinforcing layer 12 impregnated with an elastic material into a cylindrical endless reinforcing base is set between a first elastic layer 13 and a second elastic layer 14 set on the outer peripheral surface and the inner peripheral surface of the aforementioned reinforcing base respectively, and the first elastic layer 13 and the second elastic layer 14 are integrated with the elastic material impregnated into the reinforcing base of the reinforcing layer 12. The press belt 11 is a large-sized belt having a width of 2 to 15 m, a peripheral length of 1 to 30 m and a thickness of 2 to 10 mm in general.

As shown in Fig. 1, the aforementioned press belt 11 is characterized in that only the thickness of the first elastic layer 13 is progressively reduced from a central pressurizing portion C_1 of the first elastic layer 13 toward end pressurizing portions A_1

and A_1' in a pressurizing region A_1–A_1'. This is because the inventor has found out that pressure applied to the end pressurizing portions A_1 and A_1' of the press belt 11 is higher than that applied to the central pressurizing portion C_1 and also found out that nonuniformity of pressure between the press belt 11 and a roll set on the press belt 11 can be relaxed by forming the press belt 11 in the aforementioned manner. The end pressurizing portions A_1 and A_1' are located on positions separated from an end D_1 or D_1' of the overall width of the press belt 11 by a length of 0.1 to 10.0 % of the overall width D_1D_1' of the press belt 11. The central pressurizing portion C_1 is located at the center of the pressurizing region A_1–A_1'. The shape of the press belt 11 is not particularly restricted except the pressurizing region A_1–A_1'.

The difference (hereinafter referred to as "thickness difference") between the thickness C_1C_1' of the central pressurizing portion of the aforementioned press belt 11 and the thickness A_1B_1 of the end pressurizing portions is preferably 2 to 30 %, more preferably 2 to 20 % and further preferably 4 to 10 % of the thickness C_1C_1' of the central pressurizing portion. Uniformity of the pressure applied to a zonal material to be pressurized is further improved when the thickness difference is within this range.

While the method of progressively reducing the thickness of the first elastic layer 13 is not restricted, this thickness is preferably so progressively reduced as to crown a curve connecting the portions A_1, C_1 and A_1' with each other. In this case, the applied pressure is locally changed on no portion, whereby the uniformity of the pressure applied to the zonal material to be pressurized is further improved.

The aforementioned press belt 11 may be manufactured by a method of impregnating the reinforcing layer 12 consisting of an endless reinforcing base with an elastic material, hardening this elastic material thereby forming the first elastic layer 13 and the second elastic layer 14 and thereafter performing cutting, polishing or the like for progressively reducing the thickness of the first elastic layer 13 from the central pressurizing portion C_1 toward the end pressurizing portions A_1 and A_1' of the first elastic layer 13, for example.

The reinforcing base impregnated with the elastic material can be prepared from woven fabric or nonwoven fabric, for example. While generally known woven fabric can be employed as the woven fabric, for example, multiple cloth such as warp triple cloth, warp quadruple cloth or the like is preferably employed, for example. In this case, the woven fabric includes such a large number of voids that the degree of impregnation with the elastic material can be improved for attaining a sufficient anchor effect between the elastic material and the reinforcing base, whereby delamination between the elastic material and the reinforcing base can be prevented. The nonwoven fabric can be formed by dry nonwoven fabric prepared by a method such as thermal bonding, chemical bonding or air layering, wet nonwoven fabric prepared by bonding fiber with a binder or the like or nonwoven fabric prepared by a method such as spun lacing, spun bonding, melt blowing, needle punching or stitch bonding.

At least one type of natural fiber and/or at least one type of synthetic fiber can be employed as the material(s) for the aforementioned woven or nonwoven fabric. The natural fiber includes fiber such as cotton, hemp, silk or wool, for example. The synthetic fiber includes fiber such as rayon, polyester, acrylic, polypropylene, polyethylene, ultrahigh-molecular polyethylene, polyvinyl alcohol, polyurethane, polyamide, total aromatic polyamide, carbon, glass, metal or fluorine, for example.

At least one type of rubber and/or at least one type of thermoplastic elastomer can be employed as the elastic material. The rubber includes butyl rubber, natural rubber, butadiene rubber, isoprene rubber, chloroprene rubber, ethylene-propylene rubber, styrene-butadiene rubber, styrene-butadiene-styrene rubber, nitrile rubber, polynorbornene rubber, acrylic rubber, urethane rubber, silicone rubber or epichlorohydrin rubber, for example. The thermoplastic elastomer includes styrene-based, olefin-based, ester-based, polyamide-based, vinyl chloride-based or urethane-based thermoplastic elastomer, for example.

Reinforcing filamentous bodies can be arranged in the first elastic layer 13 and the second elastic layer 14. In this case, the mechanical strength of the press belt 11

can be improved. The aforementioned at least one type of natural fiber and/or at least one type of synthetic fiber can be employed for the reinforcing filamentous bodies, for example. The reinforcing filamentous bodies are preferably prepared from at least one type of fiber selected from inorganic fiber such as carbon fiber, glass fiber, boron fiber, alumina fiber, potassium titanate fiber, silica fiber or zirconia fiber or organic fiber such as total aromatic polyamide fiber, total aromatic polyester fiber, ultrahigh-molecular polyethylene fiber, high-strength vinylon fiber or high-strength acrylic fiber. In this case, the strength of the press belt 11 according to the present invention can be further improved.

The aforementioned reinforcing filamentous bodies can be used in the form of bundles of filaments, thread, roving or cords. Further, the reinforcing filamentous bodies can be arranged in unidirectional or multidirectional combination selected from the peripheral direction, the width direction and the oblique direction of the press belt 11.

(Second Embodiment)

Fig. 2 is a schematic sectional view of a press belt 21, an example of the inventive press belt, according to a second embodiment. In the press belt 21 according to the second embodiment, a reinforcing layer 22 is set between a first elastic layer 23 and a second elastic layer 24 set on the outer peripheral surface and the inner peripheral surface of a cylindrical endless reinforcing base respectively, and the first elastic layer 23 and the second elastic layer 24 are integrated with an elastic material of the reinforcing layer 22 impregnated into the reinforcing base. The press belt 21 according to the second embodiment is characterized in that the thicknesses of both of the first elastic layer 23 and the second elastic layer 24 are progressively reduced from central pressurizing portions C_2 and C_2' toward end pressurizing portions A_2 and A_2' and B_2 and B_2' respectively.

In the press belt 21 according to the second embodiment, a curve connecting the portions B_2, C_2' and B_2' in the second elastic layer 24 with each other is also preferably crowned as described above. The remaining points of the second embodiment are

similar to those of the first embodiment.

(Third Embodiment)

Fig. 3 is a schematic sectional view of a press belt 31, an example of the inventive press belt, according to a third embodiment. In the press belt 31 according to the third embodiment, a reinforcing layer 32 is set between a first elastic layer 33 and a second elastic layer 34 set on the outer peripheral surface and the inner peripheral surface of a cylindrical endless reinforcing base respectively, and the first elastic layer 33 and the second elastic layer 34 are integrated with an elastic material of the reinforcing layer 32 impregnated into the reinforcing base. The press belt 31 according to the third embodiment is characterized in that the thickness of only the second elastic layer 34 is progressively reduced from a central pressurizing portion C_3' toward end pressurizing portions B_3 and B_3' respectively.

In the press belt 31 according to the third embodiment, a curve connecting the portions B_3, C_3' and B_3' in the second elastic layer 34 with each other is preferably crowned as described above. The remaining points of the third embodiment are similar to those of the first and second embodiments.

(Fourth Embodiment)

Fig. 4 is a schematic sectional view of a press belt 41, an example of the inventive press belt, according to a fourth embodiment. In the press belt 41 according to the fourth embodiment, a reinforcing layer 42 is set between a first elastic layer 43 and a second elastic layer 44 set on the outer peripheral surface and the inner peripheral surface of a cylindrical endless reinforcing base respectively, and the first elastic layer 43 and the second elastic layer 44 are integrated with an elastic material of the reinforcing layer 42 impregnated into the reinforcing base. The press belt 41 according to the fourth embodiment is characterized in that the thickness of the first elastic layer 43 is linearly progressively reduced from a central pressurizing portion C_4 toward respective end pressurizing portions A_4 and A_4' as shown in Fig. 4, for example. In the press belt 41 according to the fourth embodiment, the thickness may be linearly progressively

reduced not only in the first elastic layer 43 but also in the second elastic layer 44 from a central pressurizing portion C_4' toward respective end pressurizing portions B_4 and B_4'. Alternatively, only the thickness of the second elastic layer 44 may be linearly progressively reduced. The remaining points of the fourth embodiment are similar to those of the first to third embodiments.

(Fifth Embodiment)

Fig. 5 is a schematic sectional view of a press belt 51, an example of the inventive press belt, according to a fifth embodiment. In the press belt 51 according to the fifth embodiment, a reinforcing layer 52 is set between a first elastic layer 53 and a second elastic layer 54 set on the outer peripheral surface and the inner peripheral surface of a cylindrical endless reinforcing base respectively, and the first elastic layer 53 and the second elastic layer 54 are integrated with an elastic material of the reinforcing layer 52 impregnated into the reinforcing base. The press belt 51 according to the fifth embodiment is characterized in that the thickness of the first elastic layer 53 is progressively reduced stepwise from a central pressurizing portion C_5 toward respective end pressurizing portions A_5 and A_5' as shown in Fig. 5, for example. In the press belt 51 according to the fifth embodiment, the thickness may be progressively reduced stepwise not only in the first elastic layer 53 but also in the second elastic layer 54 from a central pressurizing portion C_5' toward respective end pressurizing portions B_5 and B_5'. Alternatively, only the thickness of the second elastic layer 54 may be progressively reduced stepwise. The number and the shape of the steps as well as the size and the shape of each step etc. are not particularly restricted. The remaining points of the fifth embodiment are similar to those of the first to fourth embodiments.

(Sixth Embodiment)

Fig. 6 is a schematic sectional view of a press belt 61, an example of the inventive press belt, according to a sixth embodiment. In the press belt 61 according to the sixth embodiment, a reinforcing layer 62 is set between a first elastic layer 63 and a second elastic layer 64 set on the outer peripheral surface and the inner peripheral

surface of a cylindrical endless reinforcing base respectively, and the first elastic layer 63 and the second elastic layer 64 are integrated with an elastic material of the reinforcing layer 62 impregnated into the reinforcing base. The press belt 61 according to the sixth embodiment is characterized in that the thickness of the first elastic layer 63 is progressively reduced in a trapezoidal manner from a central pressurizing portion C_6 toward respective end pressurizing portions A_6 and A_6'. The thickness is progressively reduced in a trapezoidal manner by holding the thickness of the first elastic layer 63 by constant lengths C_6E_6 and C_6E_6' along the cross direction of the press belt 61 and thereafter linearly progressively reducing the thickness as shown in Fig. 6, for example. In the press belt 61 according to the sixth embodiment, the thickness may be progressively reduced in a trapezoidal manner not only in the first elastic layer 63 but also in the second elastic layer 64 from a central pressurizing portion C_6' toward respective end pressurizing portions B_6 and B_6'. Alternatively, only the thickness of the second elastic layer 64 may be progressively reduced in a trapezoidal manner. The aforementioned length C_6E_6 or C_6E_6', which is not particularly restricted, is preferably 3 to 90 % of the length $C_6'B_6$ or $C_6'B_6'$. The remaining points of the sixth embodiment are similar to those of the first to fifth embodiments.

(Seventh Embodiment)

Fig. 7 is a schematic sectional view of a press belt 71, an example of the inventive press belt, according to a seventh embodiment. In the press belt 71 according to the seventh embodiment, a reinforcing layer 72 is set between a first elastic layer 73 and a second elastic layer 74 set on the outer peripheral surface and the inner peripheral surface of a cylindrical endless reinforcing base respectively, and the first elastic layer 73 and the second elastic layer 74 are integrated with an elastic material of the reinforcing layer 72 impregnated into the reinforcing base. The press belt 71 according to the seventh embodiment is characterized in that the thickness of the first elastic layer 73 is progressively reduced from a central pressurizing portion C_7 toward respective end pressurizing portions A_7 and A_7' while a plurality of drains 75 are formed on the outer

peripheral surface of the first elastic layer 73. While the shape, the depth, the number etc. of the drains 75 are not particularly restricted, the depth of the drains 75 is preferably progressively increased from the central pressurizing portion C_7 toward the respective end pressurizing portions A_7 and A_7'. The thickness may be progressively reduced not only in the first elastic layer 73 but also in the second elastic layer 74 from a central pressurizing portion C_7' toward respective end pressurizing portions B_7 and B_7'. Alternatively, only the thickness of the second elastic layer 74 may be progressively reduced. The remaining points of the seventh embodiment are similar to those of the first to sixth embodiments.

In the press belt according to each of the first to seventh embodiments, methods of progressively reducing the thicknesses of the portions of the belt located on the right and left sides of the central pressing portion C–C' are preferably identical to each other, while the same may be different from each other.

When the thicknesses of both of the first elastic layer and the second elastic layer are progressively reduced in the press belt according to each of the aforementioned second and fourth to seventh embodiments, methods of progressively reducing the thicknesses of the first elastic layer and the second elastic layer are preferably identical to each other, while the same may be different from each other. The press belt according to the seventh embodiment can be preferably employed as a papermaking press belt in particular, above all as a shoe press belt for dehydration.

Also in the press belt according to each of the first to sixth embodiments, drains may be formed on the first elastic layer when the press belt is employed as a papermaking belt, particularly as a shoe press belt for dehydration. The application of the press belt according to the present invention described with reference to each of the aforementioned first to seventh embodiments is not particularly restricted but the press belt can be preferably employed as a belt for pressing, calendering, transfer, embossing or the like in the paper industry, the magnetic recording medium manufacturing industry, the fiber industry or the like. The press belt can be preferably employed as a belt for a

shoe press, in particular.

(Shoe Press)

The shoe press according to the present invention at least comprises the aforementioned press belt, a pressure shoe applying pressure to the press belt and pressure regulation means regulating the pressure of the pressure shoe. The pressure shoe can be prepared from a generally known metal plate or the like, for example. The pressure regulation means can be prepared from generally known hydraulic cylinders or the like, for example.

Fig. 8 is a schematic sectional view of an exemplary shoe press 80 according to the present invention. Referring to Fig. 8, both ends of a press belt 81 are fixed to discs 85 of metal rotatably supported on both ends of an unrotating support 84 through bearings, so that the shoe press belt 81 rotates in a driven manner following rotation of an unillustrated counter press roll while sliding on a pressure shoe 82. The pressure shoe 82 of a metal plate is set on hydraulic cylinders 83 serving as pressure regulation means, and these hydraulic cylinders 83 are set on a metal support 84. The pressure of the pressure shoe 82 is regulated in response to the pressure of oil supplied to the hydraulic cylinders 83 through the support 84.

A zonal material (not shown) such as wet web transported to the aforementioned shoe press 80 is subjected to pressurization such as dehydration, calendering or the like due to pressure formed between the press belt 81 forced up by the pressure shoe 82 and the depressed press roll (not shown).

The shoe press 80 according to the present invention employs the press belt 81 whose thickness is progressively reduced from a central pressurizing portion toward end pressurizing portions. Also when a portion of the support 84 close to the central pressurizing portion is deflected downward due to the depression of the press roll (not shown) and the own weight of the support 84, therefore, the pressure applied to the zonal material (not shown) is uniform in the overall pressurizing region so that the quality of products to be pressurized can be improved.

The embodiments disclosed this time must be considered as illustrative in all points and not restrictive. The range of the present invention is shown not by the above description but by the scope of claim for patent, and it is intended that all modifications within the meaning and range equivalent to the scope of claim for patent are included.

Industrial Availability

As hereinabove described, the thickness of the press belt according to the present invention is progressively reduced from the central pressurizing portion toward the end pressurizing portions, whereby the press belt can be prevented from extreme wear from the central pressurizing portion toward both end pressurizing portions, and durability of the press belt can be improved. In the shoe press, the frequency for exchanging the press belt can be reduced due to the improvement of the durability of the press belt, whereby the cost for pressurization can be reduced. According to the present invention, further, the thickness of the press belt is progressively reduced from the central pressurizing portion toward the end pressurizing portions, whereby the overall zonal material to be pressurized can be uniformly pressurized, and the quality of products to be pressed can be improved.